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(54) Vehicle powerplant featuring thermal and electrical drive means.

57 A powerplant comprising a combustion engine (1) connected to a transmission (2) via a propeller shaft (3) fitted with a clutch (4); a current generator (7) for supplying current to a storage battery (8), and powered by a countershaft (5) connected to the propeller shaft (3) via a first gear drive (6) upstream

from the clutch (4); and an electric motor (10) connected to the propeller shaft (3) via a second gear drive (11) downstream from the clutch (4); a second clutch (12) being provided between the electric motor (10) and the second drive (11).

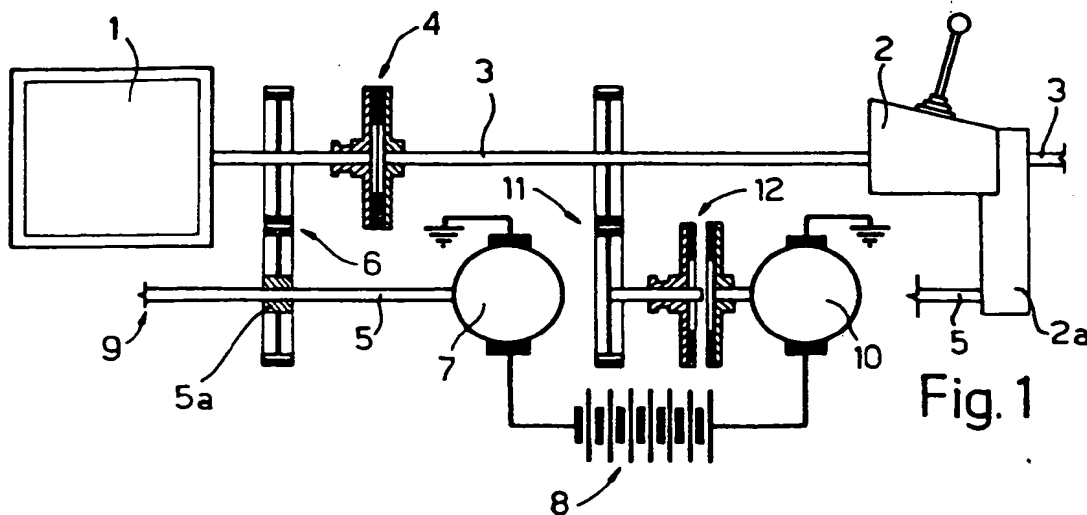


Fig. 1

EP 0 510 582 A2

The present invention relates to a vehicle powerplant comprising thermal and electrical drive means variously connectable to the input shaft of the transmission as well as to a countershaft controlling accessory devices on the vehicle.

Vehicles of the aforementioned type are employed over mixed routes allowing of little or no emission, or over which normal emission is permitted. Over the first type, the vehicle is driven solely by the electrical drive means or in controlled manner by the thermal means, whereas, over the second, the thermal drive means are operated normally. Vehicles of this type invariably feature accessory devices (e.g. hydraulic power steering pump, brake and conditioner compressors, auxiliary alternators), and at times also special-purpose devices powered by the above drive means for performing special functions for which the vehicle is designed. Both the accessory and special-purpose devices frequently demand far greater power than that required for operating the vehicle under various driving conditions.

On one known powerplant of this type, the thermal drive means comprise a combustion engine connected mechanically to the transmission input shaft by a propeller shaft fitted with a clutch designed to assume a first and second position wherein the combustion engine is respectively connected to and disconnected from the transmission input shaft.

A countershaft for powering the vehicle accessory devices is connected by a system of gears to the propeller shaft, downstream from the clutch.

The electrical drive means normally consist of a unit designed to operate as both an electric motor and current generator. The rotor element of the unit is connected to the countershaft in such a manner as to be driven by it when the unit is operated as a current generator, and to drive it for rotating the transmission input shaft when the unit is operated as a motor.

Alternatively, the rotor element of the unit is connected directly to the propeller shaft to form a single drive line between the combustion engine and the transmission input shaft, in which case, the drive line is fitted with a second clutch downstream from the unit.

The powerplant also comprises a storage battery to which current is fed by the unit when operated as a generator, and from current is drawn when the unit is operated as a motor.

Powerplants of the type briefly described above provide for two operating modes. In a first, the combustion engine is operated and the clutch (or both clutches, in the case of the alternative configuration described above) is set to the first engaged position, so that both the transmission input shaft and the countershaft are driven by the

combustion engine, while the rotor element of the unit, set to generator mode, is rotated by the countershaft for charging the batteries. In the second operating mode, the clutch is set to the second release position, and the unit alone is operated as an electric motor, the rotor element of which thus provides for powering both the transmission input shaft and the countershaft.

Powerplants of the aforementioned type present numerous drawbacks.

Firstly, in the second operating mode, i.e. when operated electrically, the accessory devices are driven solely by the power supplied by the battery, which, if of normal weight and size for the vehicle, provides for accumulating only a limited amount of energy.

Secondly, in the second operating mode, wherein the combustion engine is idle and disconnected from the drive line, current can only be generated for charging the battery when braking the vehicle, and if the unit is designed to operate as a brake, for recovering the energy produced during braking and converting it at least partially into electrical energy.

As a result, the operating range of the powerplant is fairly limited.

It is an object of the present invention to provide a powerplant of the aforementioned type designed to overcome the aforementioned drawbacks.

According to the present invention, there is provided a vehicle powerplant comprising first thermal drive means and second electrical drive means; said first and second means being activated for transmitting motion to the drive wheels of the vehicle via a transmission; said first drive means comprising a combustion engine connected mechanically to said wheels by a drive line fitted with said transmission and with a clutch located between said engine and said transmission and which may be set to a first and second position wherein said combustion engine is respectively connected to and disconnected from said transmission; characterized by the fact that it comprises:

a current generator for supplying electric current to a storage battery, and the rotor element of which is connected to said drive line upstream from said clutch;

an electric motor, the rotor element of which is connected by a first drive to said drive line downstream from said clutch, said electric motor being driven by the current supplied by said battery;

a second clutch located between the rotor element of said electric motor and said drive line, and which may be set to a first and second position wherein said rotor element of said motor is respectively connected to and disconnected from said drive line.

The design and operation of the powerplant

according to the present invention will be described by way of example with reference to the accompanying drawings, in which:

Fig.1 shows a schematic view of a first configuration of the powerplant according to the present invention;

Figs 2 and 3 show a further two configurations of the Fig.1 powerplant.

The powerplant according to the present invention comprises a combustion engine 1, e.g. a diesel engine; and a transmission 2, the input shaft of which is connected mechanically to engine 1 by a propeller shaft 3 fitted with a clutch, e.g. a friction clutch, 4. Clutch 4, which is operable in any manner, e.g. directly by the driver and/or by means of any type of actuator, is designed to assume two positions: an engaged position (Fig.1) wherein the up- and downstream portions of shaft 3 are connected; and a release position (Figs 2 and 3) wherein said portions are disconnected.

As shown clearly in the accompanying drawings, the powerplant also comprises a countershaft 5 connected mechanically to shaft 3, upstream from clutch 4, by a drive consisting, for example, of gears 6.

A current generator 7 supplies electric current to a storage battery 8, and presents a rotor element (not shown) connected to and rotated by countershaft 5.

Countershaft 5 or another shaft upstream from clutch 4 also provides for a power takeoff 9 for operating the accessory devices on the vehicle. These, in addition to standard industrial vehicle devices, such as the power steering pump, brake and conditioner compressors and auxiliary alternators, may also consist of special-purpose devices, such as compactors, in the case of refuse collection and disposal vehicles.

The powerplant according to the present invention also comprises an electric motor 10 powered by the current supplied by battery 8, and the rotor element (not shown) of which is connected to propeller shaft 3, downstream from clutch 4, by a second drive consisting, for example, of gears 11. A second clutch 12, which may be the same type as clutch 4, is located between the rotor element of motor 10 and drive 11, and is designed to assume a first engaged position (Fig.3) wherein the rotor element of motor 10 is connected to drive 11, and a second release position (Figs 1 and 2) wherein the rotor element and drive 11 are disconnected.

For the reasons explained later on, current generator 7 may conveniently be designed to also operate as an electric motor powered by battery 8, in which case, drive 6 is provided with a clutch 5a of any type, designed to assume a first and second position wherein shaft 5 of generator-motor 7 is respectively connected to and disconnected from

drive line 3 immediately downstream from engine 1. Clutch 5a may conveniently be housed in one of the gears of drive 6, as shown schematically in the accompanying drawings.

The powerplant may also comprise a further drive 2a forming part of and possibly comprising pairs of gears housed inside transmission 2, for transmitting motion from drive line 3 to shaft 5 connected to power takeoff 9. Drive 2a is activated exclusively, in known manner, with the gear lever in neutral, so that no motion is transmitted to the wheels of the vehicle.

According to a variation not shown, drive 11 may be driven from a point on drive line 3 downstream from transmission 2, as opposed to upstream as shown in the accompanying drawings, for reducing the size, particularly lengthwise, of the powerplant and so enabling troublefree installation on certain types of vehicle.

The powerplant according to the present invention operates as follows.

In a first operating mode (Fig.1), combustion engine 1 is operated with clutch 4 in the first (engaged) position and clutch 12 in the second (release) position, so that the vehicle is driven by engine 1 connected by shaft 3 to the input shaft of transmission 2. In this mode, clutch 4 is operated normally for shifting transmission 2.

At the same time, drive 6 rotates countershaft 5, which in turn rotates the rotor element of current generator 7 for charging battery 8, and operates the accessory devices on the vehicle connected to power takeoff 9.

This first operating mode therefore provides, thermally, for running the vehicle normally, operating the accessory devices, and charging the battery, and may conveniently be employed over routes involving no particular control of emission.

In a second operating mode, combustion engine 1 is again operated, but with clutch 4 in the second (release) position (Fig.2), so that only countershaft 5 and consequently generator 7 and the auxiliary devices are operated thermally. In this mode, means for controlling the speed and fuel supply of engine 1 may be provided for minimizing emission, thus enabling temporary stoppage of the vehicle for operating the accessory devices and/or charging battery 8.

In a third operating mode (Fig.3), combustion engine 1 is again operated, but with clutch 4 in the second (release) position, clutch 12 in the first (engaged) position, and electric motor 10 activated, so that shaft 3 is disconnected from engine 1 and drive 6, the input shaft of transmission 2 is powered by motor 10 via drive 11, and the vehicle is driven entirely electrically by the power drawn from battery 8. If combustion engine 1 is activated, current generator 7 is also operated simultaneously

for charging battery 8, which thus acts as a flywheel for the power supplied by engine 1 and drawn off by electric motor 10.

In this third mode, operation of engine 1 is so controlled as to maintain substantially constant engine speed and output combined with a high degree of efficiency and minimum emission for driving along controlled-emission routes.

An important point to note is that, in all three configurations described, the accessory devices are operated thermally, that is, under high power conditions, with no limitation in terms of autonomy.

Nevertheless, when drive 11 is driven from a point along line 3 upstream from transmission 2, if the power required in said third mode for operating the accessory devices is not such as to limit autonomy, and/or peak power is demanded of takeoff 9 in excess of the average designed for effectively controlling combustion engine 1 (for achieving high efficiency and minimum emission), power takeoff 9 (and, hence, shaft 5) may be controlled by drive 2a transmitting motion from transmission 2 to shaft 5 and so electrically controlling power takeoff 9.

When absolutely no emission is permitted, a fourth operating mode may be employed, which consists in de-activating engine 1 and operating the powerplant as described with reference to Fig.3, in which case, the vehicle is operated entirely electrically by battery 8.

In fourth mode (with engine 1 de-activated), power takeoff 9 may still be controlled electrically, as required for at least operating the accessory devices governing the driveability of the vehicle, such as the power steering pump and brake system devices.

For this purpose, clutch 5a is released and generator 7 set to motor mode and supplied by battery 8 for electrically powering takeoff 9.

When electrically operating the vehicle (third and fourth mode), transmission 2 can only be operated normally by means of clutch 12 if drive 11 is located upstream from the transmission. Moreover, if also designed to function as a current generator, electric motor 10 may provide for electrically braking the vehicle and at least partially recovering and converting the energy produced when braking into electrical energy, which is stored in battery 8.

To those skilled in the art it will be clear that changes may be made to the powerplant as described and illustrated herein without, however, departing from the scope of the present invention.

In particular, the rotor element of current generator 7 may be connected directly to drive line 3, upstream from coupling 4, instead of via the interposition of shaft 5 and gear drive 6 as described herein.

In this case, shaft 5 may still be connected to

line 3 via gear drive 6, as shown in the accompanying drawings, but no longer to the rotor element of current generator 7.

The above further embodiment of the powerplant obviously operates in exactly the same way as described with reference to the accompanying drawings.

Claims

1. A vehicle powerplant comprising first thermal drive means and second electrical drive means; said first and second means being activated for transmitting motion to the drive wheels of the vehicle via a transmission (2); said first drive means comprising a combustion engine (1) connected mechanically to said wheels by a drive line (3) fitted with said transmission (2) and with a clutch (4) located between said engine (1) and said transmission (2) and which may be set to a first and second position wherein said combustion engine (1) is respectively connected to and disconnected from said transmission (2); characterized by the fact that it comprises:
 - a current generator (7) for supplying electric current to a storage battery (8), and the rotor element of which is connected to said drive line (3) upstream from said clutch (4);
 - an electric motor (10), the rotor element of which is connected by a first drive (11) to said drive line (3) downstream from said clutch (4), said electric motor (10) being driven by the current supplied by said battery (8);
 - a second clutch (12) located between the rotor element of said electric motor (10) and said drive line (3), and which may be set to a first and second position wherein said rotor element of said motor (10) is respectively connected to and disconnected from said drive line (3).
2. A powerplant as claimed in Claim 1, characterized by the fact that it also comprises a shaft (5) connected by a second drive (6) to said drive line (3) upstream from said clutch (4), and which provides for a power takeoff (9) for operating the accessory devices of said vehicle; the rotor element of said current generator (7) being connected to said shaft (5).
3. A powerplant as claimed in one of the foregoing Claims, characterized by the fact that said current generator (7) is also designed to operate as an electric motor; said second drive (6) presenting a third clutch (5a) designed to assume a first position wherein said shaft (5) connected to said rotor element of said current

generator (7) is also connected to said drive line (3), and a second position wherein said shaft (5) is disconnected from said drive line (3).

4. A powerplant as claimed in one of the foregoing Claims, characterized by the fact that said first (11) and second (6) drives are gear drives.

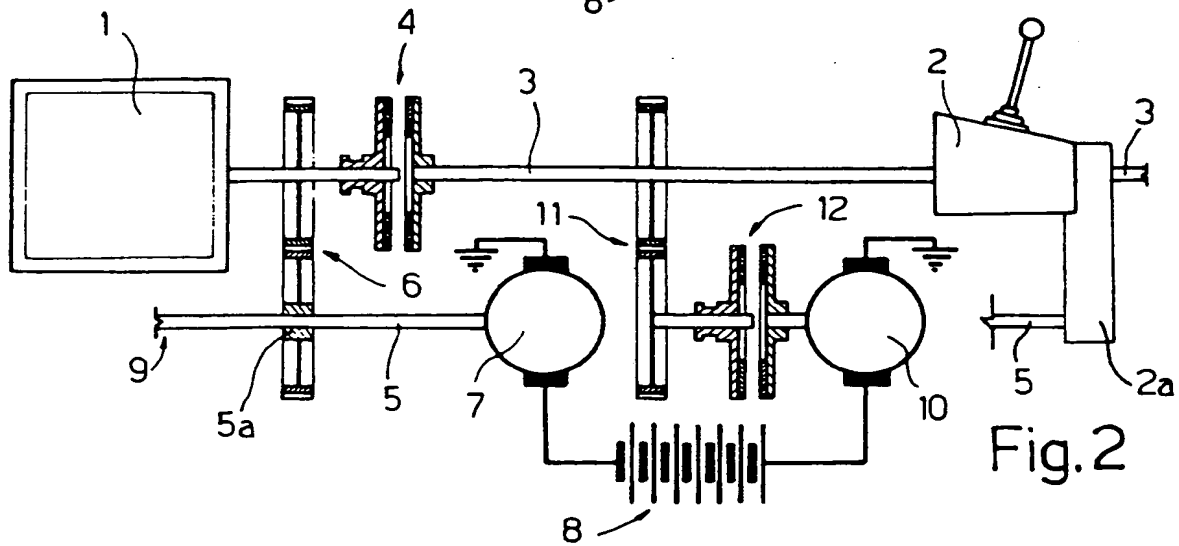
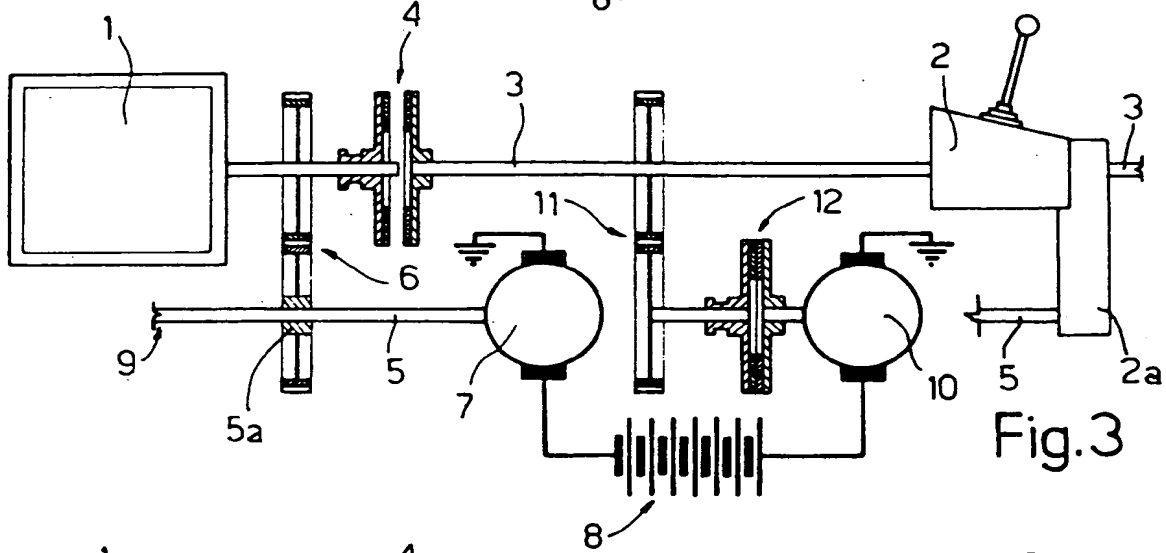
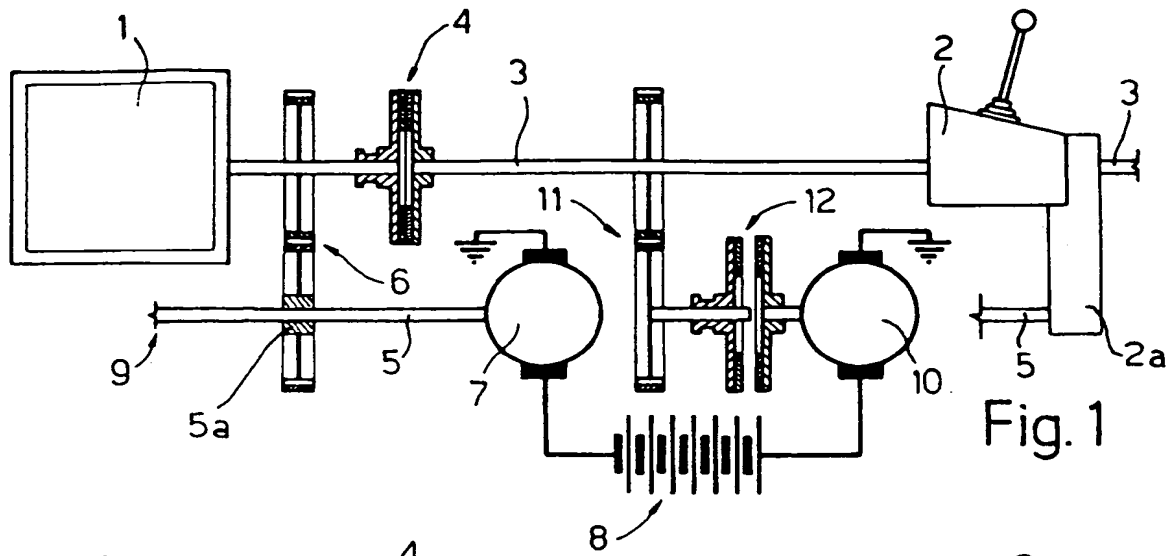
5. A powerplant as claimed in one of the foregoing Claims, characterized by the fact that said first drive (11) is connected to said drive line (3) upstream from said transmission (2).

6. A powerplant as claimed in one of the foregoing Claims from 1 to 4, characterized by the fact that said first drive (11) is connected to said drive line (3) downstream from said transmission (2).

7. A powerplant as claimed in one of the foregoing Claims, characterized by the fact that said second clutch (12) is located between said rotor element of said electric motor (10) and said first gear drive (11).

8. A powerplant as claimed in one of the foregoing Claims, characterized by the fact that it comprises a third drive (2a) for connecting said transmission (2) to said shaft (5) providing for said power takeoff (9).

9. A powerplant as claimed in one of the foregoing Claims, characterized by the fact that said electric motor (10) is also designed to operate as a current generator, for electrically braking said vehicle and generating electric current which is supplied to said battery (8).





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12

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Vehicle powerplant featuring thermal and electrical drive means.

A powerplant comprising a combustion engine (1) connected to a transmission (2) via a propeller shaft (3) fitted with a clutch (4); a current generator (7) for supplying current to a storage battery (8), and powered by a countershaft (5) connected to the propeller shaft (3) via a first gear drive (6) upstream

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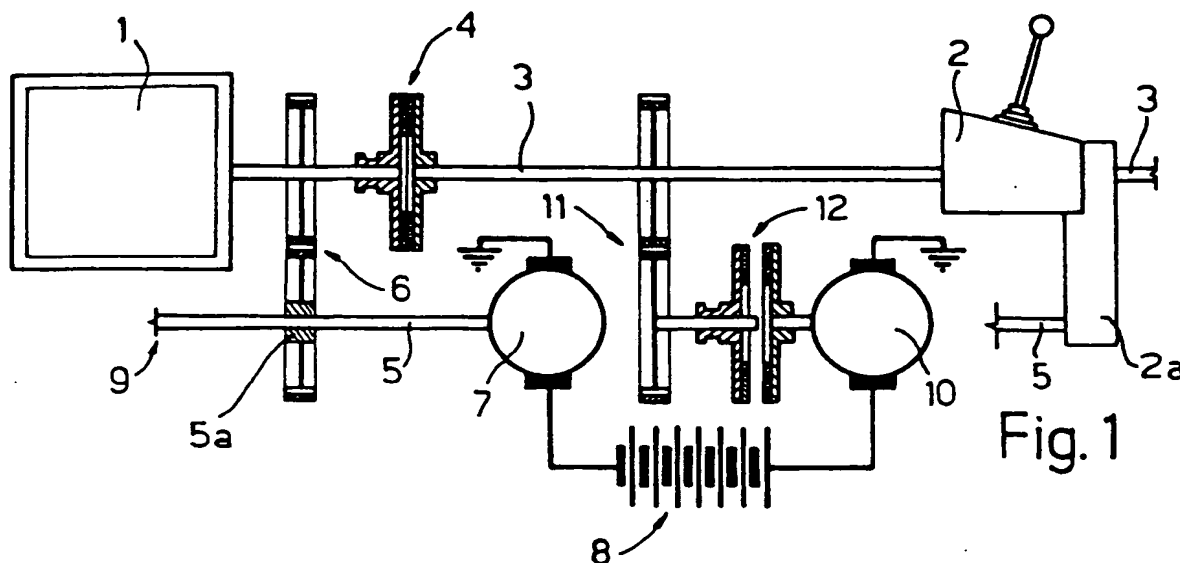


Fig. 1

EP 0 510 582 A3



European Patent
Office

EUROPEAN SEARCH REPORT

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EP 92 10 6797

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	FR-A-2 415 022 (ROBERT BOSCH) * the whole document * ---	1,2,4,7	B60K6/04 B60K17/28
A	DE-A-2 510 623 (H. KÖRNER) * the whole document * ---	1,4,7,9	
A	FR-A-2 511 954 (MAN MASCHINENFABRIK AUGSBURG-NÜRNBERG AG) * the whole document * ---	1,4,7	
A	GB-A-1 495 261 (D.B. FOSTER) * page 6, line 10 - page 7, line 29; figure 3 * ---	1,4	
A	US-A-4 319 140 (PASCHKE) * the whole document * ---	1,4,7,9	
A	DE-A-2 943 519 (VOLKSWAGENWERK AG) * page 5, line 24 - line 27 * * page 5, line 14 - page 6, line 21; figure 2 * ---	1,9	
A	US-A-3 888 325 (H. REINBECK) * the whole document * -----	1,9	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 21 SEPTEMBER 1992	Examiner TOPP-BORN S.
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